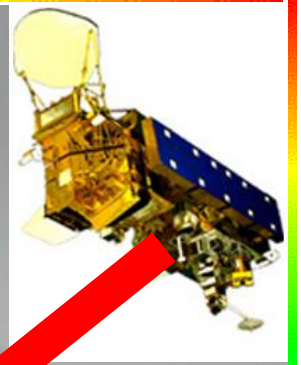
Feasibility Study of Satellite-Assisted Detection and Forecasting of Oyster Norovirus Outbreaks

Zhiqiang (Abraham) Deng



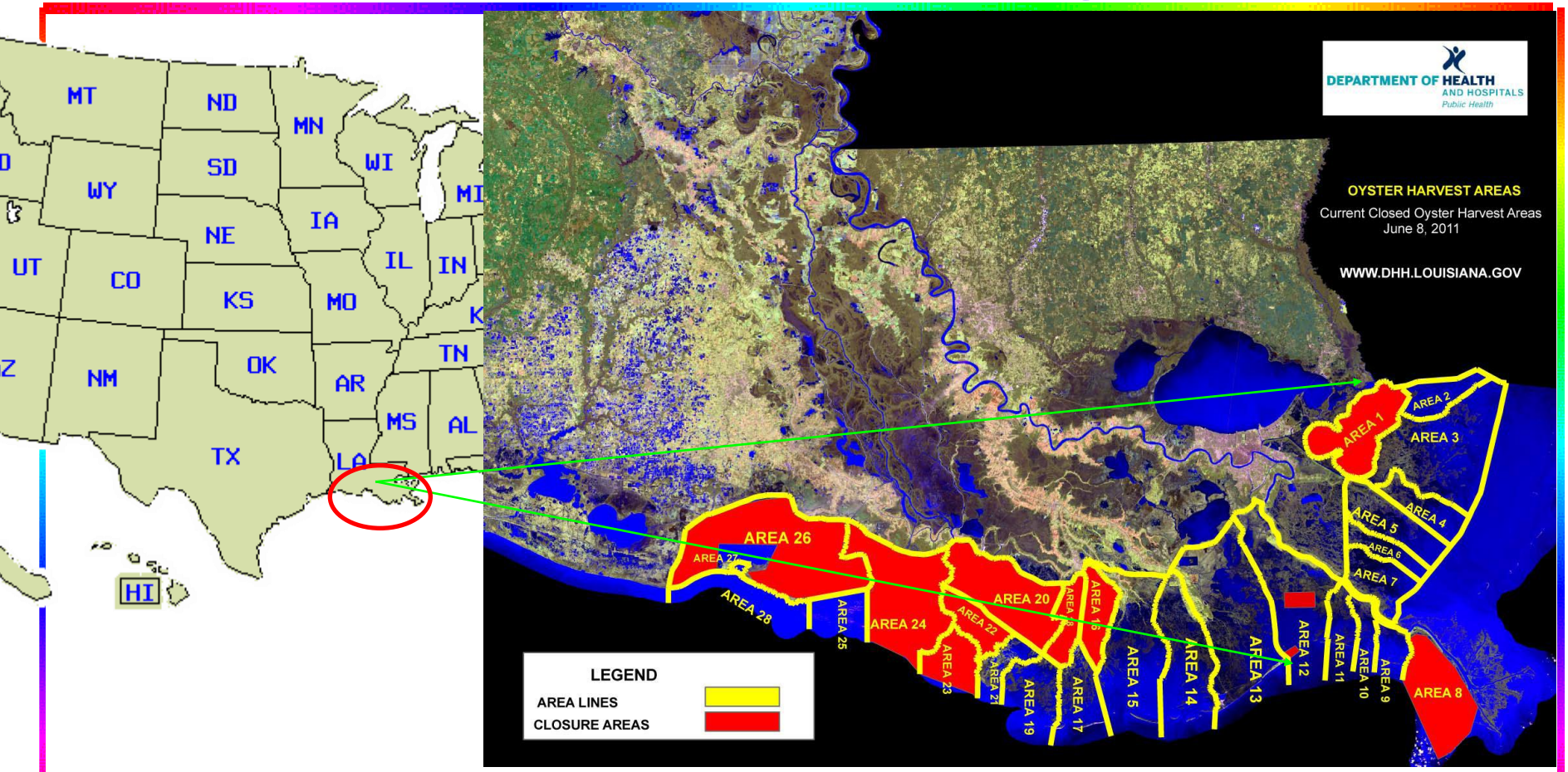
Feasibility Study of Satellite-Assisted Detection and Forecasting of Oyster Norovirus Outbreaks

- **Project Team:**
  - **PI: Zhiqiang (Abraham) Deng (Department of Civil & Environmental Engineering, Louisiana State University, Baton Rouge, LA)**
  - **Collaborators:** Gordon Leblanc, Chris Lemaire, Stephen Martin, Robert Dellsperger (Louisiana Department of Health and Hospitals)
- **Primary End-User Organization:**
  - Louisiana Department of Health and Hospitals: Molluscan Shellfish Program
- **Project Period:** 04/18/2011-04/17/2013

Outline

- Study Area & Background
- Technical Approach and Current Progress
- Anticipated Results : Detection and Forecasting System (DAFS) for oyster norovirus outbreaks
  - **Retrieval algorithms**
  - **ANN model**
  - **Hierarchical Bayesian model**
  - **GIS Interface**

Study Area: LA Oyster Growing Areas



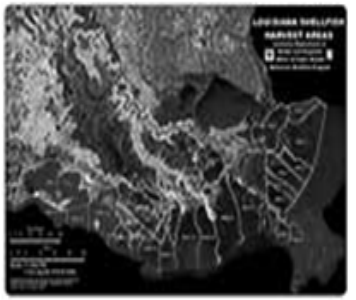
ABOUT SANITARIAN SERVICES
FOR CONSUMERS
FOR NEW BUSINESSES
FOR EXISTING BUSINESSES
COMMERCIAL SEAFOOD
EXPORT CERTIFICATES
FOOD & DRUG PROGRAM
OYSTER HARVESTING
Search Our Site...

Molluscan Shellfish Program

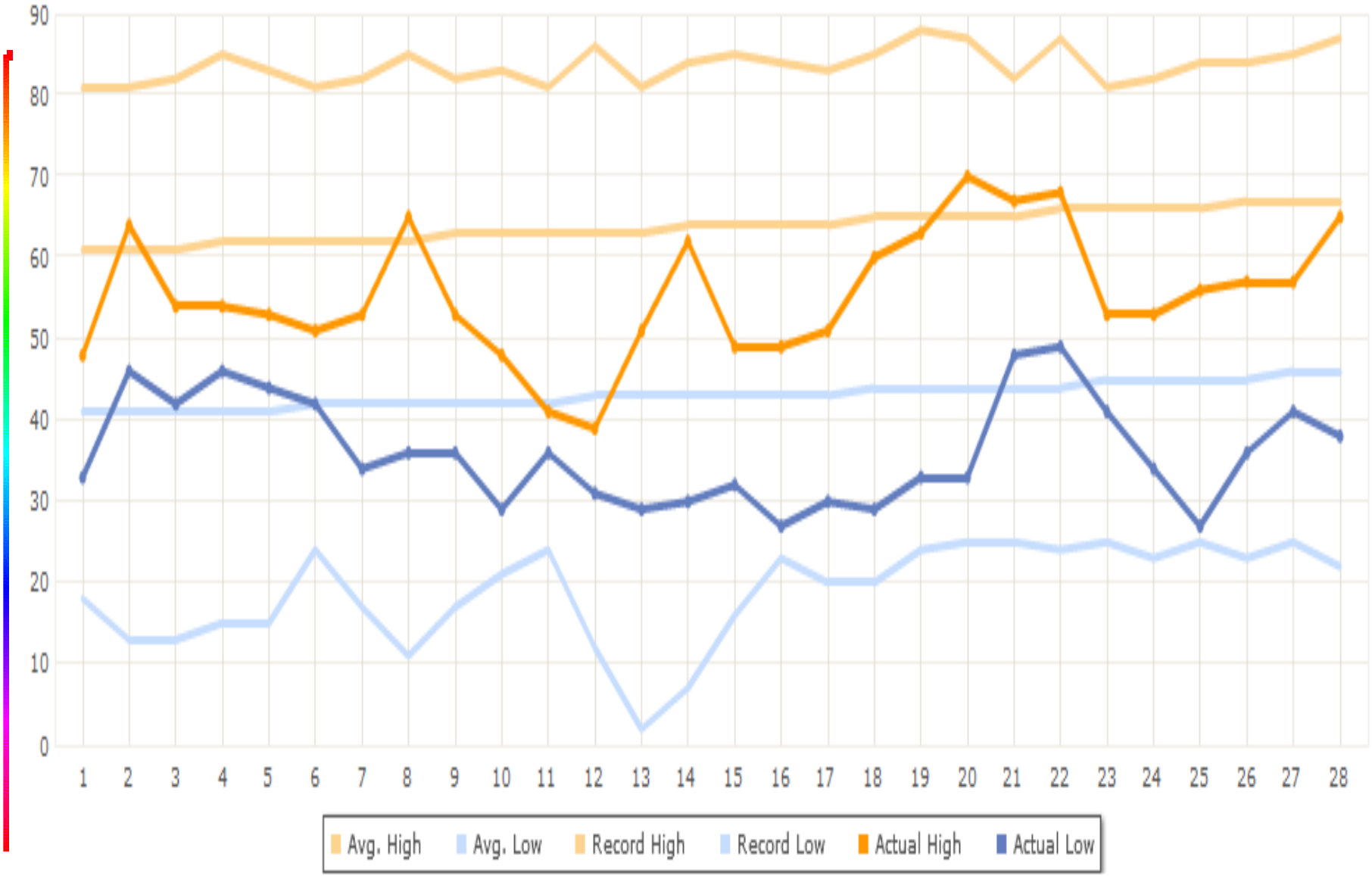
The Molluscan Shellfish Program is the regulatory agency for the oyster harvesting waters along Louisiana Gulf Coast. The harvesting areas are set forth by the Louisiana Sanitary Code and the National Shellfish Sanitation Program (NSSP). The NSSP is the federal/state cooperative program recognized by the U.S. Food and Drug Administration (USFDA) and the Interstate Shellfish Sanitation Conference (ISSC) for the sanitary control of shellfish produced and sold for human consumption. All oyster related facilities must adhere to the NSSP.

Louisiana Oysters are Safe to Eat
Oyster Testing and Baseline Samples
Sensory Training
Other Highlighted Facts

AREA	STATUS	PARISH	OYSTER HARVEST AREAS
1	CLOSED	ORLEANS/ST. BERNARD	
2	OPEN	ST. BERNARD	
3	OPEN	ST. BERNARD	
4	OPEN	ST. BERNARD	
5	OPEN	ST. BERNARD	
6	OPEN	PLAQUEMINES	
7	OPEN	PLAQUEMINES	



Temperature Graph for February 2010



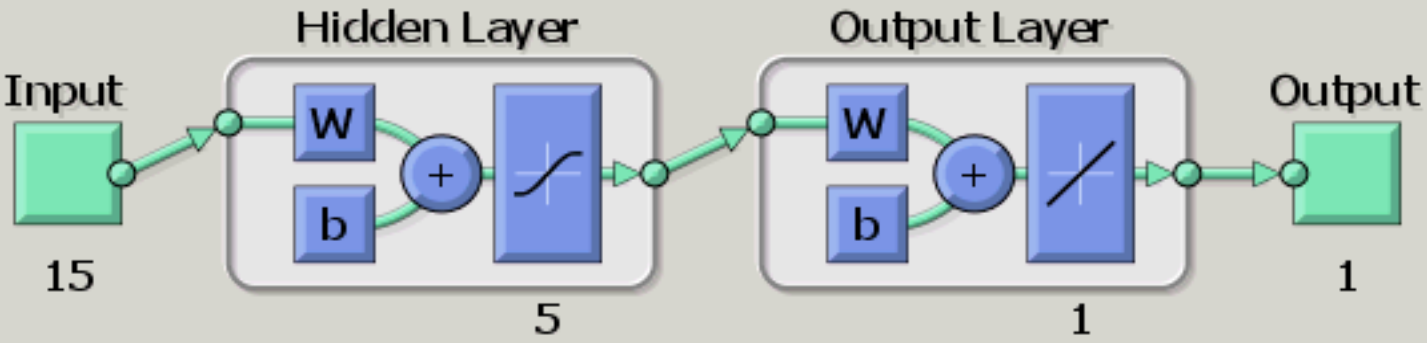
Technical Approach

- **Step-1:** Gathering norovirus outbreak data, environmental and water quality (including fecal coliform) data (from 2001 - 2010).
- **Step-2:** Linking NASA **MODIS Terra and Aqua data** to water quality indicators (such as SST, TSS, solar radiation, and salinity) controlling norovirus disease outbreaks in oyster growing waters by constructing a series of retrieval algorithms.
- **Step-3:** Developing predictive (ANN and HB) models for detection and forecasting of norovirus outbreaks using surrogate environmental and water quality parameters.
- **Step-4:** Constructing a web-enabled user-friendly GIS (Geographic Information System) platform for mapping norovirus outbreak risks.

Technical Approach To ANN model

- Selection of Independent Variables using principal component analysis and stepwise regression analysis. 15 parameters has been identified to be correlated to fecal coliform concentrations
- Using the artificial neural network (ANN) in MATLAB Toolbox to train the ANN model
- Splitting the 10 year (2001 - 2010) data sets into two subsets: one for ANN model training and the other for independent testing of the trained model.

Technical Approach: ANN Model

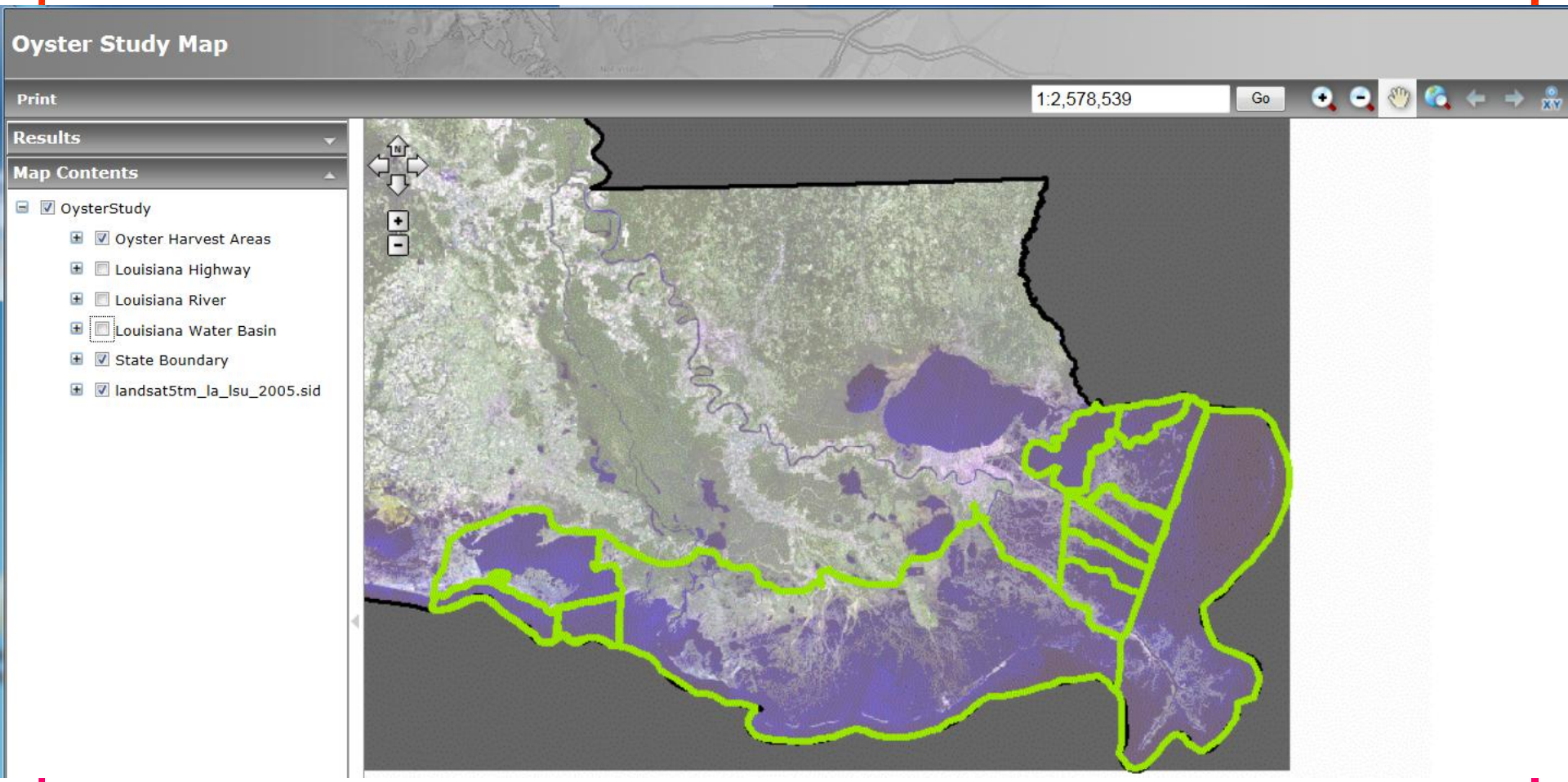


Results

	Samples	MSE	R
Training:	368	3.90037e-1	8.87414e-1
Validation:	123	7.44610e-1	7.95174e-1
Testing:	123	6.09643e-1	8.14035e-1

ANN model architecture and performance.

Technical Approach: Web-based GIS Interface



Anticipated Results

- Detection and Forecasting System (DAFS) for oyster norovirus outbreaks
  - Retrieval algorithms or water quality models that link NASA MODIS data to water quality indicators controlling norovirus disease outbreaks.
  - Artificial Neural Network model for detecting and forecasting fecal coliform (norovirus indicator organism)
  - Hierarchical Bayesian model for detection and forecasting of norovirus disease outbreak risks
  - Web-enabled and user-friendly GIS platform for mapping norovirus disease outbreak risks in a probabilistic fashion

Anticipated Results

- The **daily management (DM) decision** is based on modeling results of near-real-time input data and is capable of detecting fecal coliform levels and norovirus outbreak risks and thereby making open/close decisions on a daily basis, ***reducing the decision-making (open/close) time from current 2 – 4 months (baseline performance) to 1 day*** for the classified oyster harvesting areas. This is a significant improvement to oyster management decision-making, *markedly reducing the risk of contaminated oysters to human health* and *avoiding unnecessary oyster harvesting water closures*

Anticipated Results

- The **forecasting management (SM) decision** is based on modeling results of predicted input data and is able to map the probability of norovirus disease prevalence in oyster growing waters under favorable climate and weather conditions characterized by an extended duration of the water quality condition favoring growth of disease-causing pathogens. Based on the predicted disease prevalence map, a reclassification decision and map can be made for the potentially infected oyster harvesting waters, ***significantly reducing new cases of norovirus infections and protecting human health***

Acknowledgments

- Funding support for this research by the NASA **Public Health Program** is gratefully acknowledged.
- Data support for this research by LDHH Molluscan Shellfish Program is also greatly appreciated.

Questions ?

Zhiqiang (Abraham) Deng, Ph.D.
Ph.D., Associate Professor
Department of Civil and Environmental Engineering
Louisiana State University
Baton Rouge, Louisiana, USA
Phone: (225) 578-6850
E-mail: zdeng@lsu.edu
Deng Research Group: http://www.cee.lsu.edu/people/Deng/index.html